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AUTHOR Ling, Robert F.
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ABSTRACT

The introduction to this selective bibliography on the use of computers in teaching statistics provides a brief review of the role of the computer in statistics; the role of statistical packages; how statistical packages should be used in instruction; science, statistics, and data analysis; and choice and evaluation of statistical packages. Items listed in the bibliography are concerned both with instructional applications of computers and with the evaluation and comparison of statistical software. A copy of a questionnaire seeking information on available statistical software is appended, together with selected responses. These questionnaires were used to compile the data reported in the Index of Publicly Available Statistical Software, by Kohm, Ryan, and Velleman (1977). (LLS)

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GUIDELINES TO THE USE OF COMPUTERS IN STATISTICAL INSTRUCTION

Robert F. Ling*

ABSTRACT. In this document, the author provides the reader with an outline of basic information, as well as sources and references for further information, on topics directly related to the use of computers for statistical instruction.

*Robert F. Ling is Professor, Department of Mathematical Sciences, Clemson University, Clemson, SC 29631. Preparation of this document was supported in part by a grant from the National Science Foundation (SED 76-12191, titled "Diagnostic and Instructional Services for Undergraduate Students of Statistics", directed by Jerry A. Warren of the University of New Hampshire, Durham, NH.

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1. INTRODUCTION

The use of the computer for statistical analyses has been growing by leaps and bounds in the past decade. Some indirect evidence of this rapid growth are: the increased proportion of articles reporting computer based results in statistical journals; the large number of publicly available statistical software and packages (reported by Kohm, Ryan, and Velleman (1977), e.g.) many of which became available only within the past five years; the creation of a Section on Statistical Computing within the American Statistical Association; the initiation of Users Groups, Newsletters, special meetings, etc., associated with particular statistical packages such as SAS and SPSS, as well as increasing numbers of short courses, workshops, tutorials, and the like for various packages; and so on.

The use of the computer and statistical packages for statistical instruction, on the other hand, has been growing at a much slower pace, in comparison with other usage, whether measured in quantity or in quality. Systematic and regular use of the computer in teaching statistics is far from being universal, and may still be considered to be the exception rather than the rule, at all levels of instruction. There are many reasons for the apparent slow growth in computer-assisted instruction in statistics. Two of the main ones are: (1) Many instructors of statistics, who are knowledgeable in the subject and its traditional methods of instruction, are unfamiliar with, or ill-at-ease in, the use of the computer in general (or the particulars in the use of statistical packages) or the effective use of such facilities to assist the instruction of statistical topics. Consequently, text material and lecture notes that are independent of the computer and recent advances in its software are still widely used. (2) Of those instructors who are knowledgeable in statistical computing, the following type of sentiment is often expressed, "it is sufficiently difficult to cover the statistical material in a course without having to teach the students computing (such statements are often accompanied by laments about the students' lack of background or interest in mathematics, statistics, or computing); it would be impossible to teach them the use of statistical packages (or the computer) and still have time left to teach them statistics."

Both the above reasons can be attributed to the same cause, to a large extent. This cause might be termed "unfriendly computerese". It is quite apparent that difficult-to-learn or unnatural languages associated with operating systems and statistical packages have been deterrents to statistical computing for many instructors and students who otherwise would have made considerably more use

of them. Fortunately, the situation is steadily improving: package developers are generally paying more attention to the userinterface aspects of their products; user manuals are better written; and there are recently developed systems such as IDA and Minitab which are particularly suitable for use in conjunction with statistical instruction because of the simplicity of the languages.

In this article, the author provides the reader with an outline of basic information, as well as sources and references for further information, on topics directly related to the use of computers for statistical instruction. We believe such information will be useful to those who are contemplating the introduction of statistical packages as an aid to their teaching. Some of the information should be useful even to those who are already using the computer in their statistical instruction because they may not be aware of much of the existing resources and literature references assembled here.

2. THE ROLE OF THE COMPUTER IN STATISTICS

The computer is playing a major role today in various aspects of research, application, and instruction in statistics. In view of the tremendous power of existing computers and the availability of high quality software, statisticians not only can perform traditional computing tasks (associated with well established methodology) with utmost ease accompanied by a high degree of numerical precision, but can also approach old problems from new points of view much of which would not have been possible without the computer to perform the otherwise extremely tedious computations. Among the major areas of statistical applications in which the computer is an indispensible tool are:

A.--Monte Carlo Studies and Simulation Experiments,

B.--Routine Statistical Analysis of Large Datasets,

C.--New Methodologies Involving Large Amounts of Computing, e.g., Robust Methods, Iterative Methods, and Subsampling Methods,

D.--Exploratory Data Analysis and Model Building,

E.--Validation of Statistical Assumptions via Residuals Analyses and Graphical Methods.

3. THE ROLE OF STATISTICAL PACKAGES

Current usage of statistical packages, whether measured by the number of people engaged in those activities or the amount of computer time used, probably falls within the following categories, listed in decreasing order of usage:

A.--Descriptive and Tabular Analysis. Tools for users in their preparation of of reports involvig tabular and graphical displays of data or summaries of data.

B.--Tools for statisticians to facilitate the performance of tasks in 2.A-E.

C.--Aids to teachers in the instruction of statistics.

4. HOW STATISTICAL PACKAGES SHOULD BE USED IN INSTRUCTION

We first propose some general guidelines on the use of statistical packages in instruction, independent of how they are used to convey specific statistical concepts or to illustrate specific methodologies. They are as follows:

A.--Packages should simply be used as a tool in the proper analysis of statistical data. A proper analysis must not be constrained by what a particular package can or cannot do. Often an analysis may require the use of several different packages because of the limitations of capabilities in the "standard" packages. Sometimes, none of the existing packages will deliver what needs to be done on a particular problem, in which case special programs or routines must be written to perform the necessary tasks.

B.--The roles of statistics, statistical packages, and their interface should be clearly established. It is the duty of the instructor to convey to the students the proper concepts of statistics and the proper application of statistical methodology, regardless of what statistical packages are available, what procedures are available within a particular package, or what sorts of outputs are available within a particular procedure of a particular package.

Statistical packages (or the instruction of

material about the packages themselves) should play a supporting role to the learning and application of statistics. Far too often, students and instructors alike get too involved with the "mechanical" aspects of various software packages that students may acquire the skills to use one of more "languages" to run jobs using statistical packages, while they lack the skills to interprete the results properly or to know the appropriate strategy they should follow in analyzing the problem on hand.

C.--Theoretical concepts of statistics can often be illustrated by simple numerical examples run on statistical packages. Such demonstrations never "prove" anything but they invariably give the students a much better grasp of the theoretical concepts to have seen one or more numerical demonstrations of those concepts. The fundamental ideas underlying a sampling distribution, a confidence interval, the central limit theorem, and many other difficult theorems can easily and convincingly be illustrated by numerical examples using statistical packages.

It is very difficult, if not impossible, to set forth a set of guidelines on how to teach specific topics of statistics using the computer. To teach any particular topic, the instructional material which is optimal for an elementary level course will not be suitable for an audience in an intermediate or advanced course. Hence, even if the same statistical package is used to aid the instruction of the same topic, much care must be given to how the computational results are to be presented or used by different classes of students (at various levels). There does not appear to be any sound, general rules, nor any concentrated source of good examples. In subsection A of the Reference section, a number of recent articles are cited. These articles deal with the actual use of the computer or statistical packages at various levels of instruction, on a large number of topics. The list of articles is only intended to serve as a representative sample of recent work on computer-based methods or material in statistical instruction. Moreover, since many statistical packages are being used in instruction, only those articles about "the use of package X in teaching" are cited. Articles about "package X" or about statistical packages (but without an emphasis on their use for instruction) are purposely omitted in order to keep the list moderately small. While the computer and statistical packages are used to facilitate computational tasks association with the execution of statistical methodology, one important aspect of statistics -- its underlying philosophy -- and the impact of the computer on the

realization of the philosophy, is often overlooked in instruction, especially in elementary statistical courses. We shall briefly discuss that philosophy and approach in the next section.

5. SCIENCE, STATISTICS, AND DATA ANALYSIS

Traditional textbooks of statistics and conventional methods of instruction often fall short of the real goals of statistics, that of problem solving and analysis of real data. Textbook problems are often presented in the form of clear-cut, well-defined exercises in confirmatory analysis that bear little resemblance to the problems one is likely to encounter in the Real World.

Statistical analysis is a delicate blend of art and science. Analyzing statistical data is seldom, if ever, a one-pass affair. In addition to routine examination and display of his data for numerical accuracy, edit and transform if necessary, the statistician usually has to carry out an analysis through several iterations before arriving at some tentative conclusions. The use of the computer in instruction greatly facilitates the teaching of the realistic and proper approach to statistics. Such a philosophy and approach is articulated in the following excerpts:

"Data analysis, and the parts of statistics which adhere to it, must then take on the characteristics of a science rather than those of mathematics, specifically:

(1) Data analysis must seek for scope and usefulness rather than security.
(2) Data analysis must be willing to err moderately often in order that inadequate evidence shall more often suggest the right answer.
(3) Data analysis must use mathematical argument and mathematical results as bases for judgment rather than as basis for proof or stamps or validity." (p. 6)

"If data analysis is to be well done, much of it must be a matter of judgment, and 'theory', whether statistical or non-statistical, will have to guide, not command." (p. 10)

"The most important maxim for data analysis to heed, and one which many statisticians seem to have shunned, is this: Far better an approximate answer to the right question, which is often vague, than an exact answer to the

wrong question, which can always be made precise." (p. 13)

JOHN TUKEY (1963) "The Future of Data Analysis" in
Annals of Mathematical Statistics.

What Tukey said fifteen years ago remains timely today because exploratory data analysis entails considerably more computation, through trials and refinements, than its one-pass confirmatory analysis counterpart. Such an approach is possible, but impractical, without the support of appropriate computing software. Box(1976) reiterated the same theme in a recent article in which he said,

"In the inferential stage, the analyst acts as a sponsor of the model. Conditional on the assumption of its truth he selects the best statistical procedure for analysis of the data. Having completed the analysis, however, he must switch his role from sponsor to critic. Conditional now on the contrary assumption that the model may be seriously faulty in one or more suspected or unsuspected ways he applies appropriate diagnostic checks, involving various kinds of residual analysis." (p. 793)

"The symptoms of (cookbookery) are a tendency to force all problems into the molds of one or two routine techniques, insufficient thought being given to the real objectives of the investigation or to the relevance of the assumptions implied by the imposed methods." (p. 797)

"Mathematistry is characterized by development of theory for theory's sake, which since it seldom touches down with practice, has a tendency to redefine the problem rather than solve it." (p. 797)

GEORGE BOX (1976) "Science and Statistics" in
Journal of the American Statistical Association.

The iterative process of being a sponsor and a critic of various tentative models is most effectively carried out with the aid of appropriate interactive statistical packages or languages. The reason is that although the same steps of analysis can be carried out using packages run in the batch-mode, the long waits in turnaround between job submission and completion generally inhabit (at least deter) the statistician or the student from trying out a large number of small changes in the analysis or exploring as many alternative modes of analysis as they would under an interactive environment.

The interactive system IDA was created at a time and

environment when 5 to 6 hours turnaround for batch jobs was not uncommon, in order that exploratory analyses could be carried out in conjuction with a course in data analysis without the frustrations of long delays associated with batch computing. Since its creation in 1972, it has not only been used heavily and effectively as an aid to statistical instruction, but has also been a useful tool in many projects of serious research and real problem solving. Ling and Roberts (1975) describes the interface between interactive computing and data analysis as follows:

"Interactive computing articulates extremely well with the requirements of enlightened statistical analysis, in which the analyst examines data to help formulate an appropriate statistical model, applies diagnostic checks to criticize the model, revises the model as necessary, and continues the process until he is satisfied with that he has done about as well as he can within the given constraints of time and space. Only then does the final statistical analysis ensue, and that is relatively cut and dried." (p. 411)

"Unlike many textbook descriptions of statistical analysis, and also unlike many statistical packages (even in timesharing), IDA does not presume that an analysis need be done in a fixed sequence of operations. In order to exploit the capababilities of user-machine iteration, IDA breaks down statistical operations into relatively small modules that can be executed in any sequence that is logically possible. This permits the user to take advantage of what he has learned at each stage before deciding what to do next. Except for certain obvious restrictions in the order of execution of commands (for example, the user must first enter his data before he can edit, display, or operate on it), the user has complete freedom in going from any one command to any other. Such freedom is particularly important and useful in exploratory data analysis for regression, where, in the process of deciding on a model that does justice to what seems to be happening in the data, the user generally needs to examine residuals and fitted values for tentative models, try transformations, possibly delete observations to obtain insight into the effect of outliers, and examine various plots and numerical model-adequacy checks, not in any specific order but in an order that appears appropriate for the problem at hand, depending on the feedback and interpretation of intermediate results. Such a mode of analysis, though possible under other systems, is generally much more cumbersome to execute than in IDA." (p. 415)

ROBERT LING AND HARRY ROBERTS (1975) "IDA: An Approach to Interactive Data Analysis in Teaching and Research" in Journal of Business.

6. CHOICE AND EVALUATION OF STATISTICAL PACKAGES

A useful and up-to-date reference on the publicly available statistical software packages is the Index of Statistical Software, edited by Robert F. Kohm, Thomas A. Ryan, Jr., and Paul F. Velleman; available in microfiche form in the Proceedings of the Statistical Computing Section, American Statistical Association (1977). It consists of a compilation of the responses by 56 package developers regarding the capability, availability, portability, cost, and other relevant information about each package. In addition, abstracts of the packages (written by their developers) are provided.

Kolm, Ryan, and Velleman describe the purpose and content of the Index as follows:

"The purpose of the index is to provide a single reference capable of answering many of the first questions that may arise when an individual is trying to determine which computer program might best serve his needs. To serve this goal, the index consists primarily of three parts. Part 1 is a listing of the general capabilities of the indexed programs. The goal of this portion of the index is to cross reference programs and capabilities, e.g., which programs do ANOVA, Simple Data Descriptions, Factor Analysis, etc. The second part of the index consists of miscellaneous details about each program. This portion of the index is designed to aid the reader in determining whether the programs of interest to a particular user will run on his machine, in what computer language it is written, in what form is the program available, etc. The third portion of the index consists of the names and addresses of the developer, distributor of the program, distributor of the documentation, and the person who completed the questionnaire reply. It also contains an abstract of the computer program written by the person who completed the questionnaire, typically the developer. Virtually no guidelines were given to the developer in the writing of the abstract, so they are quite different in appearance. The abstracts provide the developers with a form in which they may describe special features of their program that are not adequately covered by the questionnaire. Many developers have chosen to describe their strong points and those features which they feel make their programs unique."

The author believes the Index will serve its goals well and that the Index (and its future editions) will prove to be an indispensible source of information about the available statistical software. The questionnaire which generated the Index is reproduced in Appendix A, and the tabulation of the responses is reproduced in Appendix B.

The Index makes no attempt to evaluate any of the indexed packages. There are many recent articles which deal with the evaluation and comparison of packages or particular routines within packages. A list of such articles is given in subsection B of the Reference section.

In choosing one or more statistical packages for instructional purposes, care should be given to the "ease of use", "handiness", or "friendliness" of the packages. A package which has a complicated control language or data structure will necessitate students spending much time learning to use the package itself, thus leaving much less time learning about statistics. Existing packages leave much to be desired in their user-interface implementations. "Unfriendly" systems and packages still abound, and they should be avoided as instructional aid in statistics, especially in courses taught at an elementary level. Many universities find it necessary to offer special 1-credit hour courses just to teach students the control language of one statistical package, such as SAS (which is one of the more "friendly" packages). The fear and frustration students may experience in using less "friendly" packages can be extrapolated from that.

7. OTHER SOURCES OF INFORMATION

Apart from journal articles, meetings, and other activities affiliated with scientific societies, there are numerous special publications and special organizations that provide services and information that are pertinent to the use of the computer in statistical instruction. Some of these are described below:

A. Information on how computers are used for instructional purposes (not limited to statistical instruction) by 367 educational institutions ranging in level from elementary schools to major universities has been compiled by the Human Resources Research Organization, published as the Academic Computing Directory (1978). The Directory not only identifies the "exemplary" institutions, but provides information on the computers they have, how they are used, and the reasons the institutions were selected as "exemplar" of academic computing. In addition, the name and address of a contact person at each institution - one who will answer questions from inquirers - is provided for each entry. Copies of the Directory are available for $3.95 each from:

Human Resources Research Organization
300 N. Washington Street
Alexandria, VA 22314

B. EDUNET is a national network of colleges and universities formed to promote the sharing of computer-based resources in higher education. The operation of EDUNET is overseen by the Planning Council on Computing in Education and Research, which was formed in 1974. The Planning Council is one of several special activities of EDUCOM - a non-profit organization established to further cooperative efforts among institutions of higher learning. EDUNET makes possible the connection of any computer terminal to many computer centers across the country. Among the statistical programs and packages accessible under EDUNET (January, 1978) are: APL, BMDP, DATAEDIT, IMSL, MANOVA, MINITAB II, SPSS, TSP (at Stanford); BMD, DATATEXT, LIDA, TPL, TSP (at Yale); FCST2***, FCST3***, FCST4***, STATNOV***, STATPROB***, STATIS*** (at Dartmouth); MINITAB, STATJOB (at Wisconsin); SCSS (at Notre Dame); and many other packages at other universities such as Cornell, MIT, Princeton, and Rice. For information about available resources and services, documentation, charges and accounting, and other EDUNET matters, one may call the toll-free EDUNET Hotline (800) 257-9505, or write to:

EDUNET Central
P. O. Box 364
Princeton, NJ 08540

News and current information items about EDUNET are provided to members (and to others upon request) by the publications EDUNET News and EDUCOM Bulletin.

C. The Symposium on the Interface of Computer Science and Statistics, held annually since 1967, consists of a series of workshops on topics involving statistical computing. Papers presented at the workshops appear in the Proceedings of the Annual Symposium. Articles on the use of computers in statistical instruction has appeared regularly in recent Proceedings.

D. The Association for Educational Data Systems (AEDS) is an organization which sponsors numerous computer related activities in education on a variety of topics, including, computer-assisted instruction, computer-managed instruction, computer-assisted guidance, computer-assisted testing, and so on. Although most of its sponsored activities are not addressed specifically to statistical instruction, many of them do apply to computer assisted instruction in statistics. Its affiliated publications (and annual subscription rate) are: the AEDS Journal ($20), the AEDS Monitor ($12), and the AEDS Bulletin ($5), all published quarterly. AEDS membership dues are $25 per year (student $10) which include subscriptions to the publications listed above.

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APPENDIX A

Available Statistical Software Questionnaire

reproduced (with permission) from

Kohm, Robert F., Ryan, Thomas A. Jr., and Velleman, Paul F. (1977), "Index of Publicly Available Statistical Software," microfiche in Proceedings of the Statistical Computing Section, American Statistical Association.

------- AVAILABLE STATISTICAL SOFTWARE QUESTIONNAIRE -------

1.1 Complete name for the package or program?

_____

1.2 Short name or abbreviation for the program?

_____

1.3 Principal developer:
Name _____
Organization_____
Department_____
Address_____
_____
Telephone (____)_____-_____

1.4 Distributor if different from (1.3) above:
Name _____
Organization_____
Department_____
Address_____
_____
Telephone (____)_____-_____

1.5 Distributor of documentation if different from (1.4):
Name _____
Organization_____
Department_____
Address_____
_____
Telephone (____)_____-_____

1.6 Person responsible for preparation of this reply if different from (1.3).
Name _____
Organization_____
Department_____
Street_____
City_____State_____Zip_____
Telephone (____)_____-_____

1.7 Date of last program release and identification (e.g. Version 5.3)
Date_____ Identification _____

1.8 Expected date of next release.
Date_____

2.1 Does the program run in batch mode?

____ (a) Yes
____ (b) No

2.2 If your program is interactive, can it run as a (One or more answers)

____ (a) Fully interactive program with prompting questions.
____ (b) Fully interactive program with answers immediately available, but without prompting questions.
____ (c) As a control card checker (i.e. essentially interactive checking of control cards for large batch-like analyses).

2.3 Program availability. (One or more replies)

____ (a) Not available for export to other computation centers?
____ (b) Passively distributed to other centers?
____ (c) Actively distributed to other centers?
____ (d) Available through time-sharing system?

2.4 If your program is available for export, how is it available? (One or more answers)

____ (a) Under a rental agreement. Cost_____

____ (b) For purchase. Cost_____

____ (c) Through some computer association such as SHARE, VIM, CUBE, DECUS, CONDUIT, etc.

2.5 If your program is available for export, how is it transported?

____ (a) In a form which is compatible with one computer brand only.
____ (b) In some readily transportable language (e.g. ANSI Fortran).
____ (c) In separate versions for different computer brands.

2.6 If your program is available for export, approximately how many centers have received copies of your program?

_____

2.7 Which of the following documentations does your program have? (One or more answers.)

____ (a) Primer intended for novice users or students with worked out examples.
____ (b) Reference manual.
____ (c) On line "HELP" selectively available "on request."
____ (d) Implementation or systems programmers guide.
____ (e) Other_____

2.8 Please check all compilers or interpreters required.

____ (a) Fortran II
____ (b) Fortran IV
ANSI
____ (c) Not verified
____ (d) Verified on Bell Labs PFORT verifier
____ (e) Verified on other verifier
____ (f) Extended FORTRAN IV
____ (g) COBOL
____ (h) PL/1
____ (i) Assembler
____ (j) BASIC
____ (k) APL
____ (l) Algol 60
____ (m) Algol 68
____ (n) Other (please specify)_____
____ (o) Special compiler (please specify)_____

2.9 On which computer makes has the program been successfully run.

Manufacturer	Model	Operating system (if important)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

2.10 Is your program:

____ (a) Under continuing development.
____ (b) Being maintained only.
____ (c) No longer being maintained.

2.11 Are local program modifications permitted?

____ (a) Yes
____ (b) No

2.12 Are local additions of capabilities permitted?

____ (a) Yes
____ (b) No

2.13 Has your program or package (or a technique unique to your program or package) ever been reviewed or described in a widely distributed journal or at a society meeting?

____ (a) Yes (please list these on a separate sheet of paper)
____ (b) No

3.1 Rank your program's strengths with respect to the following applications (1 for strongest, 2 for second strongest etc.). Do not rank inappropriate items.

_____ (a) The analysis of data.
_____ (b) Data manipulation, editing, table building, file handling.
_____ (c) Monte Carlo simulations
_____ (d) Teaching
_____ (e) Other _____

3.2 Which of the following would best describe your program? (Check only one.)

_____ (a) A stand alone main program.
_____ (b) A collection of separate main programs.
_____ (c) A special purpose statistical package or set of programs (e.g. a linear models package).
_____ (d) An integrated general purpose system of statistical routines running under a monitor.
_____ (e) A set of subroutines or similar groupings of code.

3.3 What is the principal intended audience of your program in terms of statistical experience? (check only one)

_____ (a) Complete novices with little or no statistical background.
_____ (b) Naive users with one introductory survey course in statistics.
_____ (c) A user with moderate exposure to statistics coming from advanced courses in statistics or from periodic exposure to statistical methodology.
_____ (d) An advanced or sophisticated user possessing an extensive background in statistical method and theory.

3.4 How would you describe your principal intended audience in terms of computer experience? (check only one)

_____ (a) Novices with no previous exposure to data processing or computers.
_____ (b) Naive users who may have used the computer somewhat (in a course for example).
_____ (c) Users with moderate exposure to data processing techniques and familiarity with either some languages or with experience in using statistical packages.
_____ (d) Advanced or sophisticated users with programming experience and/or data processing expertise.

3.5 For what general fields is your package intended? (One or more answers)

_____ (a) Biological sciences
_____ (b) The social sciences
_____ (c) The engineering and physical sciences
_____ (d) Business and economics
_____ (e) General statistics
_____ (f) Other(s)_____

For the Questions 4.1 - 4.30 please circle the most appropriate answer using the following replies:

C Capability	The program or package has sufficient capabilities in this area to be considered as a feature.
L Limited	The program or package has some capabilities in this area, but they should be considered as limited.
D Documented	The feature can be easily accomplished using the documentation supplied with the program, but is not a standard ("built-in") option.
F Feasible	The feature can be accomplished by users with some expertise in the area.
I Insufficient or "Blank"	The program or package has insufficient capabilities in this area to be classified above.
P Planned	The program or package has either limited or no capability in this area, but program changes are planned to include this area in the "C" classification within one year.
O Obsolete	The program developer considers the program or this aspect of the program to be obsolete.

Programs may be listed in several categories. (For example, a nonparametric analysis of variance program would be listed both in Analysis of Variance and in Nonparametric Statistics.)

THE GENERAL CAPABILITIES AREAS

Data Management

C L D F I P O	4.1	File building and manipulation.
C L D F I P O	4.2	Variable and category labeling.
C L D F I P O	4.3	Data transformations (standardization, logs, arithmetic, etc.)
C L D F I P O	4.4	Matrix computations and manipulations.
C L D F I P O	4.5	Sorting and matching.

Editing

C L D F I P O	4.6	Case selection/exclusion.
C L D F I P O	4.7	Consistency checking (simple and compound logical checks)
C L D F I P O	4.8	Automatic error correction (consistency correction, imputation, etc.)

Computations

C L D F I P O	4.9	Simple data descriptions and statistics (means, std.dev, histograms, t-test, simple linear regression, one way ANOVA, bivariate plotting, etc.)
C L D F I P O	4.10	Multiple linear regression.
C L D F I P O	4.11	Analysis of Variance (balanced data and traditional designs).
C L D F I P O	4.12	Analysis of Covariance (balanced data and traditional designs).
C L D F I P O	4.13	Canonical correlation and principal component analysis.
C L D F I P O	4.14	Factor Analysis.

C L D F I P O	4.15	Multivariate analysis of variance and discriminant analysis.
C L D F I P O	4.16	Non-linear regression.
C L D F I P O	4.17	Cluster analysis.
C L D F I P O	4.18	Simple analysis of multi-way tables (percentages, means, std. dev., etc.)
C L D F I P O	4.19	Loglinear analysis of multiway tables.
C L D F I P O	4.20	Other analysis of categorical data.
C L D F I P O	4.21	Variance estimation for complex sample designs.
C L D F I P O	4.22	Time series analyses (spectrum analysis, Box-Jenkins, forecasting, etc.)
C L D F I P O	4.23	Data smoothing and curve fitting (exponential smoothing, splines, etc.)
C L D F I P O	4.24	Bayesian statistics.
C L D F I P O	4.25	Nonparametric statistics.
C L D F I P O	4.26	Random number generation and simulation.

Output

C L D F I P O	4.27	Table printing (multi-way tables: formatted, category labels, etc.)
C L D F I P O	4.28	Graphics (versatile displays of data and intermediate results on printer, teletype, or special graphics hardware. Note: histograms and plots in which users have no control over the choice of variables, scales, or plot symbols, are here defined to be "Limited" L.
C L D F I P O	4.29	Results of computations available immediately (not in a subsequent run) as input to other procedures (e.g. residuals treated as data to other procedures.)
C L D F I P O	4.30	Results of computation and intermediate results (e.g. QR decompositions, correlation matrices, etc.) output in machine-readable form (disk/tape/cards).

---- Thank you ----

APPENDIX B

Selected Questionnaire Replies

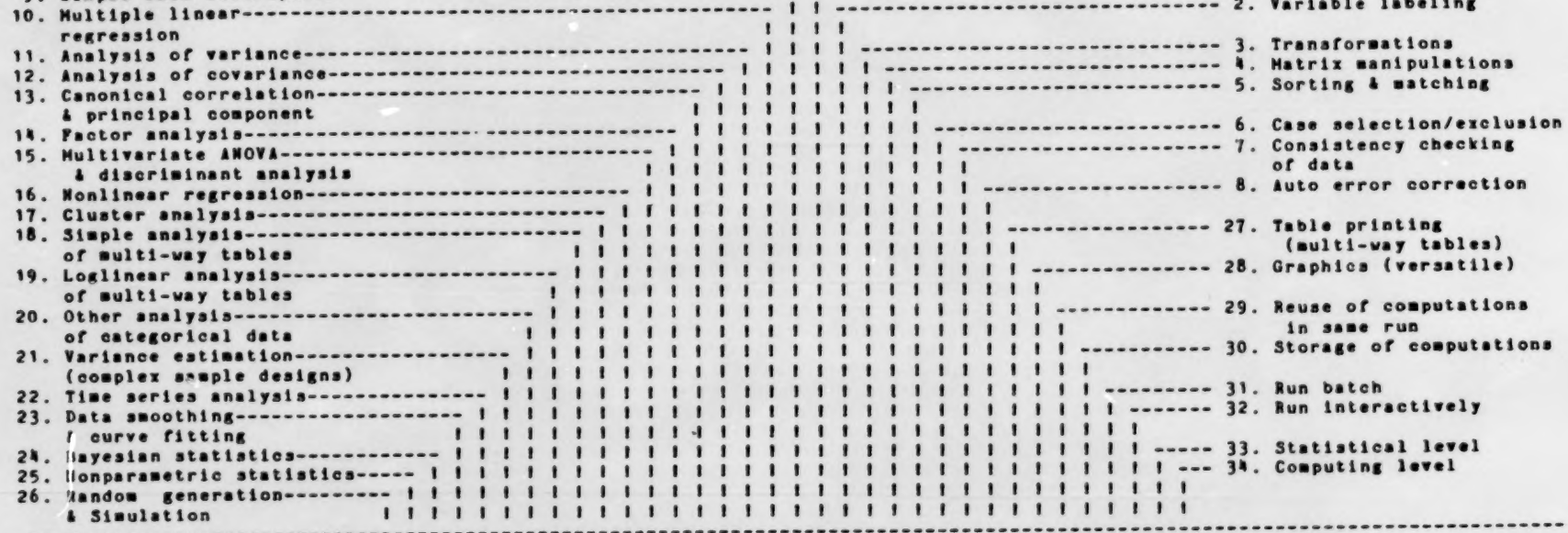
reproduced (with permission) from

Kohm, Robert F., Ryan, Thomas A. Jr., and Velleman, Paul F. (1977), "Index of Publicly Available Statistical Software," microfiche in Proceedings of the Statistical Computing Section, American Statistical Association.

9. Simple data description
10. Multiple linear regression
11. Analysis of variance
12. Analysis of covariance
13. Canonical correlation & principal component
14. Factor analysis
15. Multivariate ANOVA & discriminant analysis
16. Nonlinear regression
17. Cluster analysis
18. Simple analysis of multi-way tables
19. Loglinear analysis of multi-way tables
20. Other analysis of categorical data
21. Variance estimation (complex sample designs)
22. Time series analysis
23. Data smoothing & curve fitting
24. Bayesian statistics
25. Nonparametric statistics
26. Random generation & Simulation

1. File manipulation
2. Variable labeling
3. Transformations
4. Matrix manipulations
5. Sorting & matching
6. Case selection/exclusion
7. Consistency checking of data
8. Auto error correction
27. Table printing (multi-way tables)
28. Graphics (versatile)
29. Reuse of computations in same run
30. Storage of computations
31. Run batch
32. Run interactively
33. Statistical level
34. Computing level

Program	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	01	02	03	04	05	06	07	08	27	28	29	30	31	32	33	34	Abstract pages	I.D. #
MIT-SNAP	1						c										1	c	c	1	1	c	1	1			1	c	c			b	a	b	18 - 20	1977-001
APSTAT	1	c		1	c			1	1		c			1	f	c	c	c	c	c	c		1	c	c	1	1	1	c	c			a	c	c	21 - 22	1977-002
AQD			1		1		c	1	c	c	1	1	c	1	f	f	c	c	c	1	c	c	c	c	d	f	1	c	c	c			a	c	b	23 - 25	1977-003
The IMSL Library	c	c	p	c	c		1	p	c	c	c	c	p	c	c	c	c	c	c	1	1	c	1	1		1	1	1	c	c					c	c	26 - 29	1977-004
TABSTAT	1	c					1											c	c	f	c	c	1	c	c	1		c	c	c	f	n	a	c	c	30 - 31	1977-005
TSP/DATATRAN	c	c	c	1	c						c		1	c			1	c	c		c	c	c		c	c		c	c	c	c		a	d	a	32 - 34	1977-006
GLIM	1								c	c	f						c	c	c	1	c		1					1	c	c			b	c	b	35 - 35	1977-007
RGSP						c	p	p	c									d							c	c	f	c	p	c	c				c	c	36 - 36	1977-008
BMDP	c	c		f		p	c	c	c	c	c	c	c	c	c	c	c	c	1	c	c		1	c	c	c	c	c	c	c				a	b	37 - 41	1977-009
BMD				f	c				c		c	c	c	c	c	c	c		1	1		c	1	f		1	1	1	1				a	b	42 - 44	1977-010
WRAPS							1		1									1	c	c	1	1	c	c	c		c		c	c		c		c	45 - 46	1977-011
LINWOOD and NONLINWOOD										c					1	1	c	c		c	c	f	f				1	c	c				b	b	47 - 48	1977-012
SAS	f	1	f	f	1	c	f	f	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c		b	c	a	49 - 51	1977-013
CS	1	c	c	c	c	1	c	1	c		c	f	c	1	f	1	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	n	a	c	b	52 - 55	1977-014
P-STAT	p	1					c	p	c		c	c	c	c	c	c	c	c	c	c	c	c	c	c		c	c	c	c			b	b	b	56 - 57	1977-015
Minitab II	1	c			p		p		p				1	1	c	c	p	1	c	1	1	c	f		p	c	c	1			b	a	a	58 - 59	1977-016
SPSS	1	c				p	p	p	c		p	c	c	1	1	c	c	c	c	c		1	c	c	f	c	1		c			a	a		60 - 61	1977-017
RUMMAGE						f	1	c	f			1		c	c	1	f		1	c			f				1	1	c		c	c	b		62 - 63	1977-018
HPSTAT PACS	f	c		c	c	f	c	/	1	p	p	f	c	c	c	c	c	c	c	1	c	f	c	1	f		c	c	c	c	n	a	a	b	64 - 65	1977-019
CADA Monitor	p	p	c	p								p		f	1	c	c	c	c	c	c	p	p	c	c		c	c	c	p	n	a	b	a	66 - 67	1977-020
IMPRESS***	c	c		d	d		c	d	c	d	c	f	f	d	d	d	c	c	c	c	c	c	d	d	c	1		c	c	d	c	n	a	a	a	68 - 68	1977-021
SCSS							1	1	c								c	c	c	c	c	i		c	1		c		1	1	n	a			69 - 70	1977-022
NTSYS	1									c		1	c	c			1	1	1	c	c	c					c	1	c	c			c	b	71 - 71	1977-023
MATCAL																			c	c	c	c	c				c		c	c			a	c	72 - 72	1977-024
C-TAB II								c											c								c						c	b	73 - 73	1977-025


9. Simple data description
10. Multiple linear regression
11. Analysis of variance
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29. Reuse of computations in same run
30. Storage of computations
31. Run batch
32. Run interactively
33. Statistical level
34. Computing level

Program	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	1	2	3	4	5	6	7	8	27	28	29	30	31	32	33	34	Abstract pages	I.D. #
EFAP, COFAMM, LISREL III						c					c		c						c					c			c		c	c		c		b	74 - 75	1977-026
MULTIQUAL																			c								c							b	76 - 76	1977-027
MULTIVARIANCE												c		c	c	c	c		c	c			c				c		c	c				b	77 - 77	1977-028
LOGOG																			c								c		c					b	78 - 78	1977-029
NORMOG						c													c								c							b	79 - 79	1977-030
EXPAK																		c	c								c							b	80 - 80	1977-031
MOCA																			c								c	c						b	81 - 81	1977-032
TSAR	c	f	f	f	f	f	f	f	c	f	f	c	f	c	d	c	c	c	c	c	c	f	l	c	c	l	c	l						a	82 - 82	1977-033
GENSTAT	d	d		f		d	c	c	c	c	p	c	f	c	c	c	c	c	l	c	c	c	d	c	d	f	c	c	c	c				b	83 - 83	1977-034
SOUPAC	l	l		f	l		f		c	l	l	c	c	c	l	c	c	c	l	c	c	d	c	d			l	l	c	c				b	84 - 85	1977-035
ROSEPACK	l												c	c				c	d			c	c	c				l	c	c		a		c	86 - 86	1977-036
STATII***	d	d		c	l		f	f	f	f	f				d	c	c	c	c	c	c		c	c	c			c	c		n	a	b	a	87 - 87	1977-037
LOGLIN								c	p										l		c	l					c		c	c		a		c	b	88 - 88	1977-038
Speakeasy	l	l		c	c	f	f	f	f	f	c	c	f	c	f	c	c	c	c	p	c	c	d	l	c		c	c	c	c		a		c	a	89 - 90	1977-039
OMNITAB II	l	l					p	p	p	f	f	f	f	f	f	c	c	c	l	p	c	c	c	d	d		p	c	c	d		b	a	a	91 - 92	1977-040
AESTH																		c	d	c	d		c	d	d	d	c	l	d	d	n	c	b	b	93 - 93	1977-041
DATAPAC	c	p		p	c		p	p	c	p	p	p	p	p	p	p	p	c	c	f	f	p	c	c			l	c	c	f			c	c	94 - 95	1977-042
DATAPLOT				f	f		f			f	f					f		l			p		c				c				n	a	c	c	96 - 97	1977-043
PROBPAC																																	n	b	c	c	98 - 99	1977-044
ALSTAT	l	l		c	p								1	l	c	c	l	l	c		c	c					c	c	l		b	b	a		100 - 101	1977-045
OSIRIS	l	c				p	c		c	c	d	c	c	l	c	c	c	c	c	c	l	c	c	d	c	l	l	p	c				c	c	102 - 105	1977-046
CENTS-AID									c									l	c	c			c				c						b	c	106 - 106	1977-047
TSERIES					c													c	c	c			c		l	l		l		c			c	b	107 - 107	1977-048
EXPLORII																				c			c		l	l							c	b	108 - 108	1977-049
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9. Simple data description
10. Multiple linear regression
11. Analysis of variance
12. Analysis of covariance
13. Canonical correlation & principal component
14. Factor analysis
15. Multivariate ANOVA & discriminant analysis
16. Nonlinear regression
17. Cluster analysis
18. Simple analysis of multi-way tables
19. Loglinear analysis of multi-way tables
20. Other analysis of categorical data
21. Variance estimation (complex sample designs)
22. Time series analysis
23. Data smoothing & curve fitting
24. Bayesian statistics
25. Nonparametric statistics
26. Random generation & Simulation

1. File manipulation
2. Variable labeling
3. Transformations
4. Matrix manipulations
5. Sorting & matching
6. Case selection/exclusion
7. Consistency checking of data
8. Auto error correction
27. Table printing (multi-way tables)
28. Graphics (versatile)
29. Reuse of computations in same run
30. Storage of computations
31. Run batch
32. Run interactively
33. Statistical level
34. Computing level

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2.1 RUN BATCH	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I n	I y	I y	I n	I y	I y	I n	I n	I n	I n	I n	I n	I n	I y	I n	I n	I n	I n	I y	I y
2.2 INTERACTIVE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FULL/PROMPTS	I	I a	I a	I	I a	I a	I	I	I	I	I	I	I	I a	I	I	I	I a	I a	I a
B FULL/NOPROMPTS	I b	I	I	I	I	I b	I b	I	I	I	I	I	I b	I b	I b	I b	I	I	I	I
C CONTROL CHECKING	I	I	I	I	I	I c	I	I	I	I	I c	I	I	I	I	I	I c	I	I	I
2.3 AVAILABILITY	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NO EXPORT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B PASSIVE DISTRIB	I b	I	I	I	I	I	I	I	I	I	I b	I	I	I	I	I	I	I	I	I
C ACTIVE DISTRIB	I	I c	I c	I c	I	I c	I c	I c	I c	I c	I	I c	I c	I c	I c	I c	I c	I c	I c	I c
D VIA TIMESHARING	I	I d	I d	I	I d	I d	I	I	I	I	I	I d	I	I d	I	I	I d	I	I	I
2.4 HOW AVAILABLE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A RENTAL	I	I a	I a	I a	I	I a	I	I a	I a	I	I	I	I a	I a	I	I a	I a	I	I	I
B ONE TIME COST	I b	I	I b	I	I	I	I b	I	I b	I b	I	I	I	I	I	I	I	I	I b	I b
C COMPUTER ASSOC	I	I	I	I	I	I	I	I	I	I	I	I c	I	I	I	I	I	I	I	I
2.5 TRANSPORT METHOD	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A ONE BRAND COMPUT	I a	I	I a	I	I	I	I	I	I	I	I a	I	I a	I a	I	I	I	I	I a	I
B PORTABLE LANGUAG	I	I	I	I	I	I	I b	I b	I b	I b	I	I b	I	I	I	I b	I	I b	I	I
C DIFFERENT VERSIO	I	I c	I	I c	I	I	I c	I c	I c	I c	I	I c	I	I	I c	I	I c	I	I c	I c
2.6 NUMBER OF SITES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A 0 -10	I a	I a	I a	I	I a	I	I a	I a	I	I	I a	I	I	I a	I	I	I	I a	I a	I
B 11-99	I	I	I	I	I	I	I	I b	I	I	I	I	I	I	I b	I	I	I b	I	I b
C 100 OR MORE	I	I	I	I c	I	I c	I	I	I c	I c	I	I c	I c	I	I	I c	I c	I	I c	I
2.7 DOCUMENTATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A PRIMER	I	I	I a	I	I a	I a	I a	I a	I a	I	I	I a	I	I a	I a	I a	I a	I	I a	I
B REFERENCE	I b	I b	I b	I b	I	I b	I	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b
C ON LINE HELP	I	I	I c	I	I c	I c	I c	I	I c	I c	I	I	I	I c	I	I	I	I	I	I
D IMPLEMEN GUIDE	I	I	I	I	I	I	I	I d	I d	I d	I	I	I d	I d	I	I d	I d	I d	I	I
E OTHER	I	I	I	I	I	I	I	I	I	I	I	I e	I	I e	I	I	I	I	I	I
2.8 COMPILER & INTER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FORTRAN II	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B FORTRAN IV	I b	I b	I	I b	I	I b	I b	I b	I b	I b	I	I b	I	I b	I b	I b	I	I b	I	I
ANSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
C NOT VERIFIED	I	I	I	I	I	I c	I	I c	I	I	I	I	I	I	I	I	I	I	I	I
D PFORT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I d	I	I
E OTHER VERIFIER	I	I	I	I e	I	I	I e	I	I	I	I	I	I	I e	I	I e	I	I	I	I
F EXTENDED FORT IV	I	I f	I	I f	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
G COBOL	I	I	I	I	I	I	I	I	I	I	I g	I	I	I	I	I	I	I	I	I
H PL/1	I h	I	I	I	I	I	I	I	I	I	I	I	I	I h	I	I	I	I	I	I
I ASSEMBLER	I	I	I	I	I	I	I	I	I	I 1	I	I	I	I	I	I	I	I	I	I
J BASIC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I J	I J
K APL	I	I	I	I	I k	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
L ALGOL 60	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
M ALGOL 68	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
N OTHER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
O SPECIAL COMPILER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

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2.10 DEVELOPMENT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A CONTINUING	I a	I a	I a	I a	I a	I a	I a	I a	I a	I	I a	I a	I a	I a	I a	I a	I a	I a	I a	I a
B MAINTAINED ONLY	I	I	I	I	I	I	I	I	I	I b	I	I	I	I	I	I	I	I	I	I
C NO LONGER MAINT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2.11 LOCAL MODIFICATI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I n	I n	I n	I y	I y	I y	I y	I y	I y	I y	I n	I y	I y	I y	I n	I y	I y	I y	I y	I y
2.12 LOCAL ADDITIONSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I n	I n	I y	I y	I y	I y	I n	I y	I y	I y	I n	I y	I y	I y	I y	I y	I y	I y	I y	I y
2.13 REVIEWED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I n	I n	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y
3.1 RANK STRENGTHS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A DATA ANALYSIS	I 1	I 1	I 1	I 1	I 1	I 2	I 2	I 1	I 1	I 1	I 3	I 1	I 1	I 1	I 2	I 2	I 1	I 1	I 1	I 2
B MANIPULATION	I	I 2	I 2	I 4	I 1	I 3	I 3	I 1	I 3	I 3	I 2	I	I 2	I 2	I 1	I 4	I 2	I 3	I 2	I 3
C SIMULATION	I	I 4	I	I 2	I	I 4	I	I	I 4	I	I	I	I	I	I	I 3	I 4	I	I	I
D TEACHING	I 2	I 3	I 3	I 3	I 3	I 5	I 2	I	I 2	I 2	I	I 2	I	I 3	I 3	I 1	I 3	I 2	I	I 1
E OTHER	I	I	I	I	I	I 1	I	I	I	I	I 1	I	I	I 3	I	I	I	I	I	I
3.2 BEST PROG DESC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A MAIN PROGRAM	I	I	I	I	I	I	I a	I	I	I	I	I	I	I	I	I	I	I	I	I
B SEP MAIN PROGRAMI	I	I	I	I	I	I	I	I	I	I b	I	I b	I	I	I	I	I	I	I b	I
C SPECIAL PURPOSE	I	I	I	I	I	I	I	I c	I	I	I	I	I	I	I	I	I c	I	I	I
D INT. SYSTEM	I d	I d	I d	I	I d	I d	I	I	I d	I	I	I	I d	I d	I d	I d	I d	I	I	I d
E SUBROUTINES	I	I	I	I e	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3.3 STATISTICAL EXP	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I a	I	I	I	I	I	I	I	I a	I a	I	I	I	I	I	I a	I a	I	I a	I
B NAIVE	I	I	I	I	I	I	I	I	I b	I b	I	I b	I	I	I b	I	I	I	I	I b
C MODERATE	I	I c	I c	I c	I c	I c	I	I c	I c	I c	I	I	I c	I c	I	I	I	I c	I	I
D ADVANCED	I	I	I	I	I	I d	I	I	I d	I d	I	I	I	I	I	I	I	I	I	I
3.4 COMPUTER EXPER.	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I	I	I	I	I	I a	I	I	I	I	I	I	I a	I	I	I a	I a	I	I	I a
B NAIVE	I b	I	I b	I	I	I	I b	I	I b	I b	I	I b	I	I b	I b	I	I	I b	I b	I
C MODERATE	I	I c	I	I c	I c	I	I	I c	I c	I c	I c	I	I	I	I	I	I	I	I	I
D ADVANCED	I	I	I	I	I	I	I	I	I d	I d	I	I	I	I	I	I	I	I	I	I
3.5 GENERAL FIELDS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A BIOLOGICAL SCIENI	I	I	I	I a	I	I	I a	I a	I a	I a	I	I a	I a	I	I	I a	I	I a	I a	I a
B SOCIAL SCIENCES	I	I	I b	I b	I	I	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b
C ENG & PHYSICAL	I	I	I	I c	I	I	I c	I c	I	I	I c	I c	I	I	I	I c	I	I c	I c	I
D BUSINESS & ECON	I	I	I d	I d	I d	I d	I	I d	I	I	I d	I d	I d	I d	I d	I d	I	I	I d	I
E GEN. STATISTICS	I a	I e	I e	I e	I e	I	I e	I e	I e	I e	I e	I e	I e	I e	I e	I e	I e	I e	I e	I e
F OTHER	I f	I	I	I	I f	I	I	I	I	I	I	I	I	I f	I	I	I	I	I f	I

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2.1 RUN BATCH	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I n	I n	I n	I n	I n	I n	I n	I n	I n	I n	I n	I n	I n	I y	I y	I y	I y	I n
2.2 INTERACTIVE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FULL/PROMPTS	I a	I a	I	I	I	I	I	I	I	I	I	I	I	I	I	I a	I a	I a	I a	I
B FULL/NOPROMPTS	I b	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I b	I b
C CONTROL CHECKING	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2.3 AVAILABILITY	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NO EXPORT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B PASSIVE DISTRIB	I b	I	I b	I	I	I	I	I	I	I	I	I b	I	I	I b	I	I	I b	I	I
C ACTIVE DISTRIB	I	I c	I	I c	I c	I c	I c	I c	I c	I c	I c	I	I c	I	I	I c	I	I	I c	I c
D VIA TIMESHARING	I d	I d	I	I	I	I	I	I	I	I	I	I	I d	I	I	I	I d	I d	I d	I
2.4 HOW AVAILABLE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A RENTAL	I	I a	I	I	I	I a	I	I	I	I	I	I a	I	I	I	I	I	I	I	I
B ONE TIME COST	I b	I	I b	I b	I b	I	I b	I b	I b	I b	I b	I	I b	I	I b	I b	I	I b	I	I b
C COMPUTER ASSOC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2.5 TRANSPORT METHOD	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A ONE BRAND COMPUT	I a	I a	I a	I	I	I	I	I	I	I	I	I a	I	I	I a	I	I	I	I	I
B PORTABLE LANGUAG	I	I	I	I	I	I	I	I	I	I	I	I b	I	I	I	I b	I	I b	I	I b
C DIFFERENT VERSIO	I	I	I	I c	I c	I c	I c	I c	I c	I c	I c	I	I	I c	I c	I c	I	I	I c	I
2.6 NUMBER OF SITES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A 0 -10	I	I	I	I a	I	I	I	I	I a	I a	I a	I a	I	I	I	I a	I a	I	I	I
B 11-99	I b	I b	I	I	I b	I b	I b	I b	I b	I	I b	I	I b	I b	I b	I	I	I b	I	I b
C 100 OR MORE	I	I	I c	I	I	I	I	I c	I	I	I	I	I	I	I	I	I	I	I c	I c
2.7 DOCUMENTATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A PRIMER	I a	I a	I	I	I	I	I	I a	I	I	I	I	I a	I a	I	I	I a	I a	I a	I a
B REFERENCE	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I	I b	I b	I b	I b
C ON LINE HELP	I c	I c	I	I c	I c	I c	I c	I	I c	I	I	I	I	I	I	I c	I	I c	I c	I
D IMPLEMEN GUIDE	I d	I d	I d	I	I	I	I	I	I	I	I	I	I d	I d	I d	I	I	I d	I d	I d
E OTHER	I	I	I	I	I	I	I	I	I	I	I	I	I	I e	I e	I e	I e	I	I e	I e
2.8 COMPILER & INTER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FORTRAN II	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B FORTRAN IV	I	I b	I b	I	I	I	I	I	I	I	I b	I b	I b	I	I b	I b	I	I	I	I b
ANSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
C NOT VERIFIED	I	I	I c	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
D PFORT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I d	I	I	I	I
E OTHER VERIFIER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I f	I	I	I	I
F EXTENDED FORT IV	I	I	I	I f	I f	I f	I f	I f	I f	I f	I	I	I	I	I	I	I	I	I	I
G COBOL	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
H PL/1	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I ASSEMBLER	I	I i	I	I	I	I	I	I	I	I	I	I	I i	I	I i	I	I	I	I	I
J BASIC	I j	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
K APL	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
L ALGOL 60	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
M ALGOL 68	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
N OTHER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I n	I	I
O SPECIAL COMPILER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I o	I	I	I

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2.10 DEVELOPMENT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A CONTINUING	I a	I a	I a	I a	I	I a	I a	I a	I a	I a	I a	I	I a	I a	I a	I a	I a	I	I a	I a
B MAINTAINED ONLY	I	I	I	I	I b	I	I	I	I	I	I	I b	I b	I	I	I	I	I	I	I
C NO LONGER MAINT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2.11 LOCAL MODIFICATI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I y	I y	I n	I y	I y	I y	I y	I y	I y	I y	I n	I y	I y	I n	I y	I n	I y
2.12 LOCAL ADDITIONSI		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I y	I y	I n	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y
2.13 REVIEWED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I n	I y	I n	I y	I y	I y	I n	I n	I n	I y	I y	I y	I y	I y	I y	I y	I y
3.1 RANK STRENGTHS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A DATA ANALYSIS	I 2	I 3	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1	I 1
B MANIPULATION	I 3	I 1	I	I 3	I	I	I	I	I	I	I	I	I 2	I 2	I 2	I	I 3	I	I 2	I 3
C SIMULATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I 4	I	I	I 5	I	I	I 4
D TEACHING	I 1	I 2	I	I 2	I 2	I 2	I 2	I 2	I 2	I 2	I 2	I	I 3	I 3	I 4	I 2	I 4	I 2	I 3	I 2
E OTHER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I 3	I	I 2	I	I	I
3.2 BEST PROG DESC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A MAIN PROGRAM	I	I a	I	I	I a	I	I a	I a	I a	I a	I a	I a	I	I a	I	I	I a	I a	I	I
B SEP MAIN PROGRAMI		I b	I	I	I	I b	I	I	I	I	I	I	I	I	I	I	I	I	I	I
C SPECIAL PURPOSE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I c	I	I	I	I
D INT. SYSTEM	I d	I d	I d	I	I	I	I	I	I	I	I	I	I d	I	I d	I	I	I	I d	I
E SUBROUTINES	I	I	I	I e	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3.3 STATISTICAL EXP	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I a	I	I	I a	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I a	I
B NAIVE	I	I	I	I	I	I	I	I	I	I b	I b	I b	I	I	I	I	I b	I	I b	I
C MODERATE	I	I	I c	I	I c	I c	I c	I	I	I	I	I	I c	I c	I c	I c	I	I c	I c	I c
D ADVANCED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I d
3.4 COMPUTER EXPER.	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I a	I	I	I	I	I	I	I	I	I	I	I	I a	I	I	I	I a	I	I a	I a
B NAIVE	I	I	I b	I	I b	I b	I b	I b	I b	I b	I b	I b	I	I b	I b	I	I	I b	I	I
C MODERATE	I	I	I	I c	I	I	I	I	I	I	I	I	I	I	I	I c	I	I	I	I
D ADVANCED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3.5 GENERAL FIELDS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A BIOLOGICAL SCIENI		I	I a	I a	I a	I a	I a	I a	I a	I	I a	I a	I	I a	I a	I a	I	I a	I a	I
B SOCIAL SCIENCES	I b	I	I b	I b	I b	I b	I b	I b	I b	I	I b	I b	I	I b	I b	I b	I	I b	I b	I
C ENG & PHYSICAL	I	I	I	I c	I c	I c	I c	I c	I	I	I	I	I	I c	I	I c	I c	I c	I c	I c
D BUSINESS & ECON	I	I	I	I d	I d	I d	I d	I d	I d	I	I d	I d	I	I	I d	I d	I d	I d	I	I
E GEN. STATISTICS	I	I	I	I e	I e	I e	I e	I e	I	I	I	I	I e	I e	I e	I	I e	I	I e	I e
F OTHER	I	I	I	I	I	I	I	I	I f	I f	I	I	I	I	I	I	I	I	I	I f

Selected Questionnaire Replies

IDENTIFICATION	77-41	77-42	77-43	77-44	77-45	77-46	77-47	77-48	77-49	77-50	77-51	77-52	77-53	77-54	77-55	77-56
2.1 RUN BATCH	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I n	I n	I y	I n	I n	I n	I n	I n	I n	I n	I n	I n	I y	I n	I y	I n
2.2 INTERACTIVE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FULL/PROMPTS	I	I	I a	I	I	I	I	I	I	I	I	I	I a	I	I a	I
B FULL/NOPROMPTS	I	I	I b	I b	I b	I	I	I	I	I b	I	I	I	I	I	I
C CONTROL CHECKING	I c	I	I	I	I	I	I	I	I	I c	I	I	I	I	I	I
2.3 AVAILABILITY	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NO EXPORT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B PASSIVE DISTRIB	I b	I	I	I	I	I	I	I	I	I	I	I b	I	I	I	I
C ACTIVE DISTRIB	I	I c	I c	I c	I c	I c	I c	I c	I c	I c	I c	I	I c	I c	I c	I c
D VIA TIMESHARING	I	I	I	I	I	I d	I d	I	I	I d	I	I	I d	I	I	I
2.4 HOW AVAILABLE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A RENTAL	I	I	I	I	I	I	I	I	I	I	I	I	I a	I	I	I a
B ONE TIME COST	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b	I
C COMPUTER ASSOC	I	I	I	I	I	I	I	I	I	I	I	I	I c	I	I	I
2.5 TRANSPORT METHOD	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A ONE BRAND COMPUT	I	I	I	I	I	I	I a	I	I	I a	I a	I	I	I	I	I a
B PORTABLE LANGUAG	I b	I b	I b	I b	I b	I	I	I b	I b	I	I	I b	I b	I b	I b	I
C DIFFERENT VERSIO	I	I	I	I	I	I c	I	I	I	I	I	I	I	I c	I c	I
2.6 NUMBER OF SITES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A 0 -10	I	I	I a	I a	I a	I	I	I a	I	I	I	I a	I a	I	I	I
B 11-99	I b	I b	I	I	I	I	I b	I	I b	I b	I	I	I	I	I b	I b
C 100 OR MORE	I	I	I	I	I	I c	I	I	I	I	I c	I	I	I c	I	I
2.7 DOCUMENTATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A PRIMER	I	I a	I a	I a	I	I a	I	I	I	I	I a	I	I a	I	I	I a
B REFERENCE	I	I b	I b	I	I b	I b	I b	I b	I b	I b	I b	I b	I	I	I	I b
C ON LINE HELP	I	I	I c	I c	I c	I	I	I	I	I	I	I	I c	I	I c	I
D IMPLEMEN GUIDE	I	I	I	I	I	I d	I d	I	I	I d	I	I	I	I d	I d	I
E OTHER	I e	I e	I	I	I	I e	I	I	I	I e	I	I	I	I	I e	I
2.8 COMPILER & INTER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FORTRAN II	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B FORTRAN IV	I	I	I	I	I b	I b	I	I b	I b	I	I	I b	I b	I	I b	I b
ANSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
C NOT VERIFIED	I	I	I	I	I	I	I	I c	I c	I	I	I	I	I	I c	I
D PFORT	I	I d	I d	I d	I d	I	I	I	I	I	I	I	I	I	I	I
E OTHER VERIFIER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
F EXTENDED FORT IV	I	I	I	I	I	I	I	I	I	I	I	I	I	I g	I	I
G COBOL	I	I	I	I	I	I	I g	I	I	I	I	I	I	I	I	I
H PL/1	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I ASSEMBLER	I	I	I	I	I i	I i	I	I	I	I i	I	I	I	I	I	I i
J BASIC	I j	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
K APL	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
L ALGOL 60	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
M ALGOL 68	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
N OTHER	I	I	I	I	I	I	I	I	I	I n	I n	I	I n	I	I	I
O SPECIAL COMPILER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

Selected Questionnaire Replies

IDENTIFICATION	77-41	77-42	77-43	77-44	77-45	77-46	77-47	77-48	77-49	77-50	77-51	77-52	77-53	77-54	77-55	77-56
.10 DEVELOPMENT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A CONTINUING	I a	I a	I a	I a	I a	I a	I a	I	I	I	I a	I a	I a	I	I a	I a
B MAINTAINED ONLY	I	I	I	I	I	I	I	I b	I b	I b	I	I	I	I b	I	I
C NO LONGER MAINT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
.11 LOCAL MODIFICATI		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I y	I y	I y	I n	I y	I y	I y	I y	I y	I n	I y	I y	I y
.12 LOCAL ADDITIONS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I y	I y	I y	I n	I y	I y	I y	I y	I y	I y	I y	I y	I y
.13 REVIEWED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I n	I n	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y
.1 RANK STRENGTHS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A DATA ANALYSIS	I 1	I 1	I 1	I	I 1	I 1	I 1	I	I 1	I	I 2	I 2	I 1	I 3	I 1	I 1
B MANIPULATION	I	I 3	I	I	I	I 2	I 1	I	I	I 2	I 1	I 1	I 2	I 1	I 4	I 2
C SIMULATION	I	I 2	I	I	I	I	I	I	I	I	I	I	I 3	I	I 5	I
D TEACHING	I 2	I 4	I 2	I	I	I	I	I 2	I 2	I	I	I 4	I 2	I 3	I 3	I
E OTHER	I	I	I 3	I 1	I	I	I	I	I 1	I 3	I	I	I 4	I 2	I	I
.2 BEST PROG DESC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A MAIN PROGRAM	I a	I	I	I	I	I	I	I a	I a	I	I a	I	I	I	I	I
B SEP MAIN PROGRAMI		I	I	I	I	I	I	I	I	I	I	I	I	I b	I	I
C SPECIAL PURPOSE	I	I	I	I c	I c	I	I	I	I	I	I	I c	I c	I	I	I
D INT. SYSTEM	I	I	I	I	I	I d	I d	I	I	I d	I	I	I	I	I d	I d
E SUBROUTINES	I	I e	I	I	I	I	I	I	I	I	I	I	I	I	I	I
.3 STATISTICAL EXP	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I a
B NAIVE	I b	I	I	I	I b	I	I b	I	I	I	I	I	I b	I	I	I
C MODERATE	I	I c	I c	I c	I	I c	I	I c	I c	I c	I c	I c	I	I c	I c	I
D ADVANCED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
.4 COMPUTER EXPER.	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I	I	I	I	I a	I	I	I	I	I a	I a	I	I a	I	I	I a
B NAIVE	I b	I	I	I	I	I	I	I b	I b	I	I	I	I	I b	I b	I
C MODERATE	I	I c	I c	I c	I	I c	I c	I	I	I	I	I c	I	I	I	I
D ADVANCED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
.5 GENERAL FIELDS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A BIOLOGICAL SCIENI	a I	I	I	I	I	I	I a	I a	I a	I a	I a	I	I a	I	I a	I
B SOCIAL SCIENCES	I b	I	I	I	I	I b	I b	I b	I b	I b	I b	I b	I	I b	I b	I b
C ENG & PHYSICAL	I c	I	I	I	I c	I	I	I c	I c	I c	I	I	I	I	I	I
D BUSINESS & ECON	I d	I	I	I	I d	I d	I d	I d	I d	I d	I d	I	I	I d	I d	I
E GEN. STATISTICS	I e	I e	I e	I e	I	I e	I e	I e	I	I e	I e	I	I	I	I e	I
F OTHER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I